

DRAFT TECHNICAL REPORT: Water Quality **Pocono Creek Pilot Study ONLY 10/30/01**

The following text is a working technical document. This draft technical report can be referred to when making out the matrix for Management Issues within the Pocono Watershed.

Please concentrate on TEXT, and the delivery of information. Tables, Maps, Graphs are not yet numbered. The Final Draft will contain all sequential numbering labels. Also, due to the limitations of the WORD program, random page breaks occur, splits in text, etc. These will be corrected in the final copy.

WATER QUALITY

Through examination of available data, it is concluded that the Water Quality of the Pocono Creek Watershed generally is good. Statewide minimal standards are exceeded with the exception of temperature, which frequently exceeds these standards. Locations that reported multiple data points where readings either exceeded minimum standards or were not consistent with the remainder of the watershed have been identified as Areas of Concern. Dissolved Oxygen and Temperature were the most common water quality parameter of concern. Averages of Management Area water quality parameters have been established to support computer modeling of the site in Phase II and to support development of the water quality targets to support the goals of the study. The findings were consistent with the level of impervious cover reported in the watershed (Schueler 1994).

Methodology-

The first step in assessing the current water quality of Pocono Creek was to determine what sampling data was available. After identifying the sources and collecting the data, the data was compiled in a master spreadsheet. Next the collected data was scrubbed for errors, and then examined for overall completeness. Plots of the individual parameters were examined by date, management area, and whether it was a tributary or main stem sample location. Parameter averages were computed for the Pocono Creek by management area. Finally, areas of concern were identified.

The study team benefited that multiple agencies and watershed groups collected samples on the Pocono from 1985 through the present.

Brodhead Watershed Association (1985 - current)

Water Temperature, pH (field), turbidity, Nitrate, Phosphate

Pocono Township (1986 – current)

Water Temperature, Dissolved Oxygen, pH, Ammonia, Total Phosphorus, Fecal Coliform, BOD-5, Total Dissolved Solids, Aluminum

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Monroe County Planning Commission (1985- current)

Water Temperature, Dissolved Oxygen, ph (field and lab), Conductivity, Hardness, Alkalinity, Nitrite, Nitrate, Ammonia, Total Phosphorous, Chloride, Acidity, Fecal Coliform, BOD-5

1987 – added Total Aluminum, Dissolved Aluminum, Chlorine Residual

1988 – added Total Suspended Solids (dropped chlorine residual)

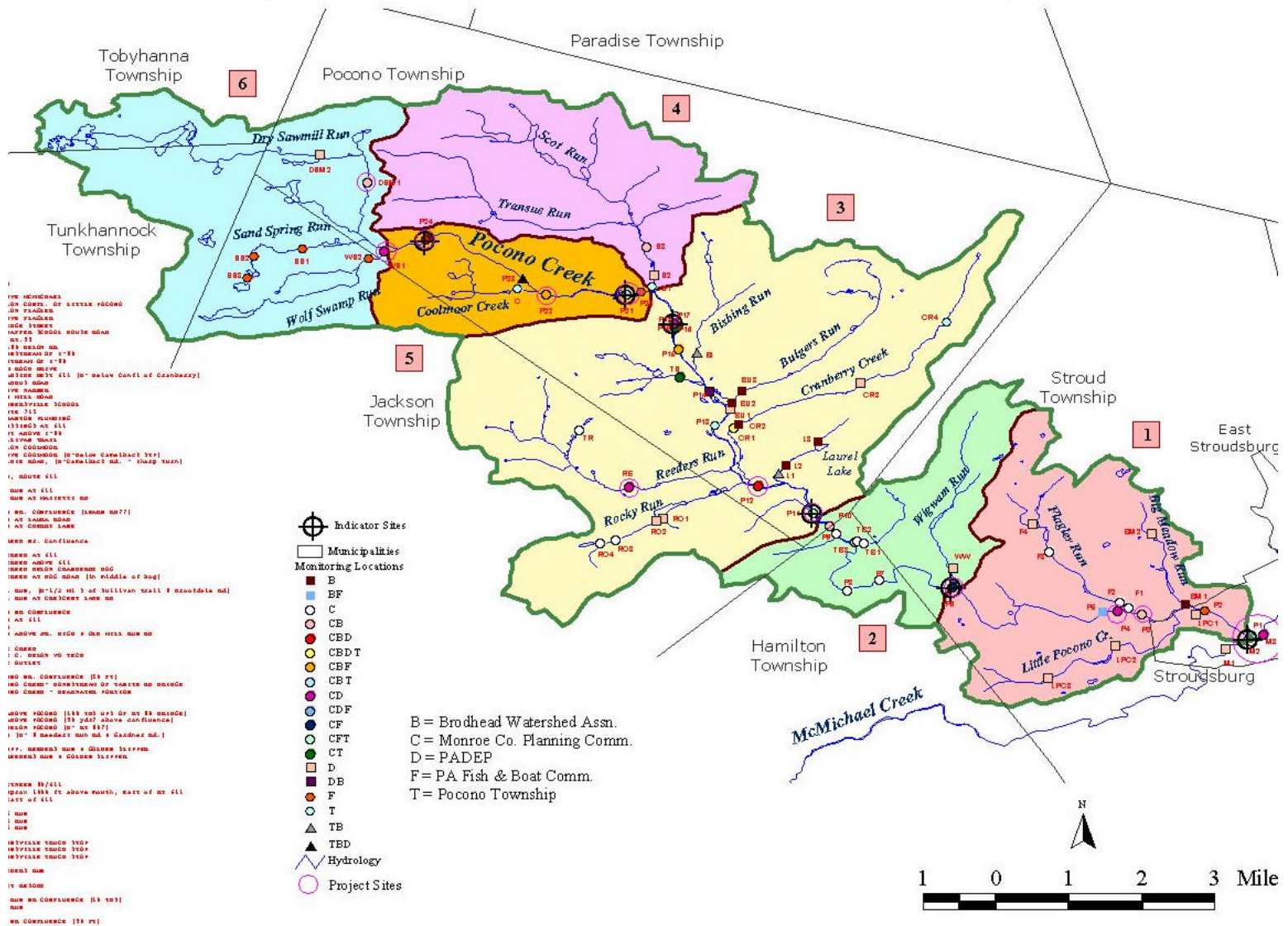
1990 - added Total Dissolved Solids (dropped aluminum)

1999 - added Total Nitrogen Test

Additional data was included from limited PaDEP and USGS records. Overall, the database consisted of well over 1300 data “records”, from close to 70 sampling sites. Each record contains multiple parameters depending on the agency involved. Figure 1 shows the sampling locations on the watershed while Table 1 & 2 gives the reader some idea on the coverage of the sites by year and agency.

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**Pocono Creek Pilot Study
Historic Water Quality, Macroinvertebrate, & Fish Data**



- Sample Locations - Source - DRBC

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Table 1 - Sampling Locations - Pocono Creek Main Stem

KEY

Site Identifiers

P - Pocono Creek

M - McMichaels Creek

* - Tributaries to the Pocono

KEY: Sampling Agencies

C - Monroe County Planning Commission

T - Pocono Township

B - Brodhead Watershed Ass

D - PADEP

F - PA Fish & Boat Comm.

SITE #	Mgt. Entity Areas	DESCRIPTION	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
P1	1 CDF	POCONO, ABOVE MCMICHAEL		F									C
P2	1 F	POCONO, BELOW CONFL. OF LITTLE POCONO		F									
P3	1 CB	POCONO, BELOW FLAGLER			C		C				B	B	
P4	1 CD	POCONO, ABOVE FLAGLER			C	C							
P5	1 BF	POCONO, BRIDGE STREET			F						B	B	B
P6	2 CF	POCONO, SCHAFER SCHOOL HOUSE ROAD											
P7	2 C	POCONO, UP RT.33	C										
P8	2 C	POCONO, W-180 BELOW RR		C									
P9	2 C	POCONO, DOWNSTREAM OF I-80				C		C	C	C			C
P10	2 CB	POCONO, UPSTREAM OF I-80				C		C	C	C	B	B	B
P11	3 CTF	POCONO, RIM ROCK DRIVE		T	T	T	T	T	T	T	T	T	T
P12	3 CDB	POCONO, ROADSIDE REST 611 (D- Below Confl of Cranberry)	C								B	B	B
P13	3 T	POCONO, STADDUS ROAD		T	T	T	T	T	T	T	T	T	T
P14	3 DB	POCONO, ABOVE WARNER	B								B	B	B
P15	3 CBF	POCONO, OLD MILL ROAD			C						B	B	B
P16	3 CT	POCONO, TANNERSVILLE SCHOOL			T/C	T	T	T	T	T	T	T	T
P17	3 C	POCONO, ROUTE 715		C									
P18	3 CB	POCONO, SCRANTON PLUMBING			C						B	B	B
P19	3 CD	POCONO, CROSSINGS AT 611	C		C	C	C			C	C		
P20	5 F	POCONO, JUST ABOVE I-80											
P21	5 CTB	POCONO, SULLIVAN TRAIL		T	T	T	T	T	T	T	T	T	T
P22	5 CBF	POCONO, BELOW COOLMOOR											
P23	5 TDB	POCONO, ABOVE COOLMOOR (D-Below Camelback STP)		T	T	T	T	T	T	T	T	T	T
P24	5 CDB	POCONO, WILKIE ROAD, (D-Camelback Rd. - sharp turn)	C	C							C/B	B	B
M1	NA D	MCMICHAEL ABOVE POCONO (100 YDS UPS OF RT 80 BRIDGE)											
M2	NA C	MCMICHAEL ABOVE POCONO (30 yds? above confluence)											C
M3	NA CD	MCMICHAEL BELOW POCONO (D- Rt 80?)											C

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Table 2 - Sampling Locations - Pocono Creek Tributaries

KEY: Site Identifiers		KEY: Sampling Agencies											B - Brodhead Watershed Ass D - PADEP T - Pocono Township F - PA Fish & Boat Comm.	
SITE #	Mgt. Area	Entire	DESCRIPTION	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
BM1	1	B	BIG MEADOW RUN AT 611											
BM2	1	D	BIG MEADOW RUN AT MAZZETTI RD											
F1	1	C	FLAGLER RUN NR CONFLUENCE			C	C	C	C	C				
F2	1	C	FLAGLER RUN AT 611			C	C	C	C		C			
F3	1	C	FLAGLER RUN			C	C							
F4	1	D	FLAGLER RUN ABOVE JR. HIGH & OLD MILL RUN RD											
LPC1	1	D	LITTLE POCONO NR. CONFLUENCE (50 FT)											
LPC2	1	D	LITTLE POCONO CREEK- DOWNSTREAM OF TANITE RD BRIDGE											
LPC3	1	D	LITTLE POCONO CREEK - HEADWATER PORTION											
TB1	2	C	TRIB, BARTONSVILLE TRUCK STOP						C	C	C			
TB2	2	C	TRIB, BARTONSVILLE TRUCK STOP						C	C	C			
TB3	2	C	TRIB, BARTONSVILLE TRUCK STOP						C	C	C			
WW	2	D	WIGWAM RUN NR CONFLUENCE (30 FT)											
BI	3	TB	BISBING RUN, ROUTE 611		T	T	T	T	T	T	T	T/B	T/B	T/B
BU1	3	D	BULGERS RUN NR. CONFLUENCE (LEARN RD??)											
BU2	3	B	BULGERS RUN AT LAURA ROAD											
BU3	3	B	BULGERS RUN AT CHERRY LANE									B	B	
CR1	3	CTDB	CRANBERRY CREEK AT 611				T	T	T	T	T	T	T	T/B
CR2	3	B	CRANBERRY CREEK ABOVE 611									B	B	B
CR3	3	D	CRANBERRY CREEK BELOW CRANBERRY BOG											
CR4	3	T	CRANBERRY CREEK AT BOG ROAD (in middle of bog)		T	T	T	T	T	T	T	T	T	T
L1	3	TB	LAUREL LAKE CREEK						T	T	T	T/B	T/B	T
L2	3	B	LAUREL LAKE C. BELOW VO TECH									B	B	
L3	3	B	LAUREL LAKE OUTLET									B	B	
RE	3	CD	REEDERS RUN (D- @ Reeders Run Rd & Gardner Rd.)									C		
RO1	3	D	ROCKY RUN,OPP. REEDERS RUN & GOLDEN SLIPPER											
RO2	3	D	ROCKY RUN,REEDERS RUN & GOLDEN SLIPPER											
RO3	3	C	ROCKY RUN					C						
RO4	3	C	ROCKY RUN					C						
TR	3	C	TRIB OF REEDERS RUN							C	C			
TS	3	CT	TRIB, SUMMIT RESORT			T	T/C	T	T	T	T	T	T	T
S1	4	T	SCOT RUN BETWEEN 80/611		T	T	T	T	T	T	T	T	T	T
S2	4	D	SCOT RUN-Approx 1000 ft above mouth, East of Rt 611											
S3	4	CB	SCOT RUN, East of 611			C	C			C	C	C/B	B	B
C	5	T	COOLMOOR CREEK Nr. Confluence		T	T	T	T	T	T	T	T	T	T
DSM1	6	CB	DRY SAWMILL RUN, (D-1/2 Mi S of Sullivan Trail @ Brookdale Rd)									B	B	B
DSM2	6	D	DRY SAWMILL RUN AT CRESCENT LAKE RD											
SS1	6	F	SAND SPRING RUN											
SS2	6	F	SAND SPRING RUN											
SS3	6	F	SAND SPRING RUN											
WS1	6	CD	WOLF SWAMP RUN NR CONFLUENCE (10 YDS)											
WS2	6	F	WOLF SWAMP RUN											

The list of water quality parameters compiled in the study is detailed below in Table 3. An explanation of these parameters is found in Appendix ##. Generally the temperature, dissolved oxygen, pH and Total Dissolved Solids parameters were tested in the field using portable instruments (See county summary reports). In most cases the testing limits were low enough so as not to interfere with analysis of the data. One notable exception is the five day biochemical oxygen demand, or BOD-5. The report limit of 2 mg/l allows use as a screening criteria, but prevents use of the average of the data. Further discussion of this topic will be presented later in this report.

Table 3 also annotates which tests are included in the statewide water quality standards (Chapter

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93, Annex A). This reference sets the limits for differing categories of protected streams, and illustrates that these tests are suitable for this type of analysis.. The County added six dissolved metals to their August 2000 sampling, since this parameter was lacking from previous sampling efforts. The Table below also notes where the “Pennsylvania Water Quality Standards,” (Chapter 93) were used to determine if there was a water quality concern.

Table 3- Water Quality Parameters – Pocono Creek

<u>General Parameters</u>	<u>Chap 93</u>	<u>Nutrients</u>	<u>Chap 93</u>
Water Temperature	Y	Ammonia	Y
Dissolved Oxygen	Y	Nitrite	Y*
pH (field)	Y	Nitrate	Y*
		Phosphate	Y
Fecal Coliform	Y	Total Phosphorus	Y
BOD-5			
Total Dissolved Solids (Conductivity)	Y	<u>Metals</u>	
Total Suspended Solids		Aluminum	Y
Hardness	Y		
Chloride	Y	*Note: Added together in Chapter 93	
Acidity			

Note: “Y” represents when the State Water Quality Standards (Chapter 93) were used to designate parameters for determining water quality in Pocono Creek.

Extensive data manipulations were required while developing the database. First units were checked and standardized. Next the database was corrected for typographical errors (“o” for zero), etc. Last, it was corrected for test limits. For example, BOD-5 reported much of the data as < 2.0 mg/l, and Fecal Coliforms as <20 or < 100, and many nutrients were listed as not detected (ND). For the Fecal Coliforms the number was set at either the 20 or 100 value, and it is felt that the average of the test results is still useful, as the average reading is an order of magnitude higher then the test limit. The same is not true for BOD-5, and it can only be used to screen for areas of concern. For Nutrients the “ND’s” were set at zero, and as with the Fecal Coliforms, the test accuracies are high enough so the average of the data is usable.

It is very difficult to compare water temperature readings from different times of the year, and understand the significance of the readings. So it was decided to report this data as the difference between the state standards and the temperature reading. As the state standards vary by month, this allows for a better comparison. A negative (“-N”) temperature reading is to be interpreted as that number (N) of degrees below the minimum standard, thereby surpassing the minimum standard (cooler is better).

Finally, the database was constructed to facilitate review of the results. Each water quality

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parameter was graphed and reviewed by date, location, management area, and whether it is part of the tributary or directly located on Pocono Creek. Averages of each parameter were determined by management area. These averages and the minimal state standards (where applicable) are included on each graph.

Areas of Concern were identified as sample locations where multiple samples either were above state standards, or not in line with readings of the rest of the watershed (usually at least 2 – 4 times higher). It was found that these areas were easily recognized when inspecting the data plotted by site location and management area.

Results-

The water quality of the creek is generally good, with some identified areas of concern. This is further supported by the percent imperviousness of the watershed. The distribution of the sampling data is not consistent, and there may be many more areas of concern or parameters for these areas missed due to lack of data.

Multiple studies show the health of a stream starts to deteriorate rapidly after the percent imperviousness exceeds 10% (CWP – 1999). Table 4 shows the percent imperviousness of the Pocono as developed by DRBC. Note that while the Management Areas 1 & 2 has impervious percentages far greater than 10%, the overall percent imperviousness for the drainage area to those points is still around the 10% mark. You would expect to start seeing some impacts of degradation of the water quality in the Pocono Creek as you reached the lower areas, and more areas of concern in the tributaries of the lower two management areas.

Table 4 - Percent Imperviousness of the Pocono Creek Watershed

Management Area - (Tributaries)			Contributing Area (Pocono Creek)	
Management Area	Size Acres	Percent Impervious	Size Acres	Percent Impervious
6	5445	7	5445	7
5	2193	7	7638	8
4	4161	6	4161	6
3 Top			11799	7
3 Bot	11485	10	23284	9
2	2776	19	26061	10
1	4712	22	30773	11

Sample Results - 1 – Total Dissolved Solids

Total Dissolved Solids (TDS) is a good indicator of water quality. Changes may be due to increased population of septic tanks, algae blooms, etc. The statewide maximum standard is 500 mg/l for water supply, though a higher criteria of 133% of the ambient stream concentration is required for

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Special Protection Waters. Figures 2 and 3 show the data for the Pocono Creek and its tributaries over time. Generally it is clear that the majority of TDS readings are low, well below the statewide maximum. It is tempting to note that the larger more recent readings on the Pocono Creek are related to urbanization, however this cannot be supported statistically. Both the average and spread of the tributary data is higher than the creek, as the impact of the urbanization is not masked and pockets of higher concentration occur.

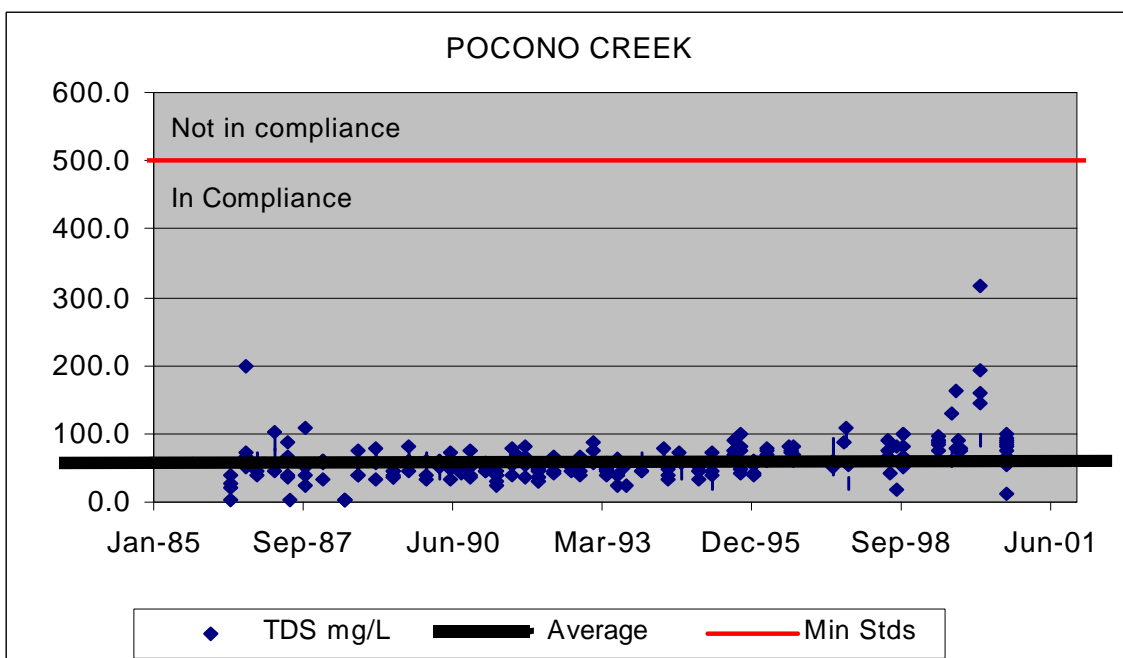


Figure 2 - TDS - Pocono Creek - By Date

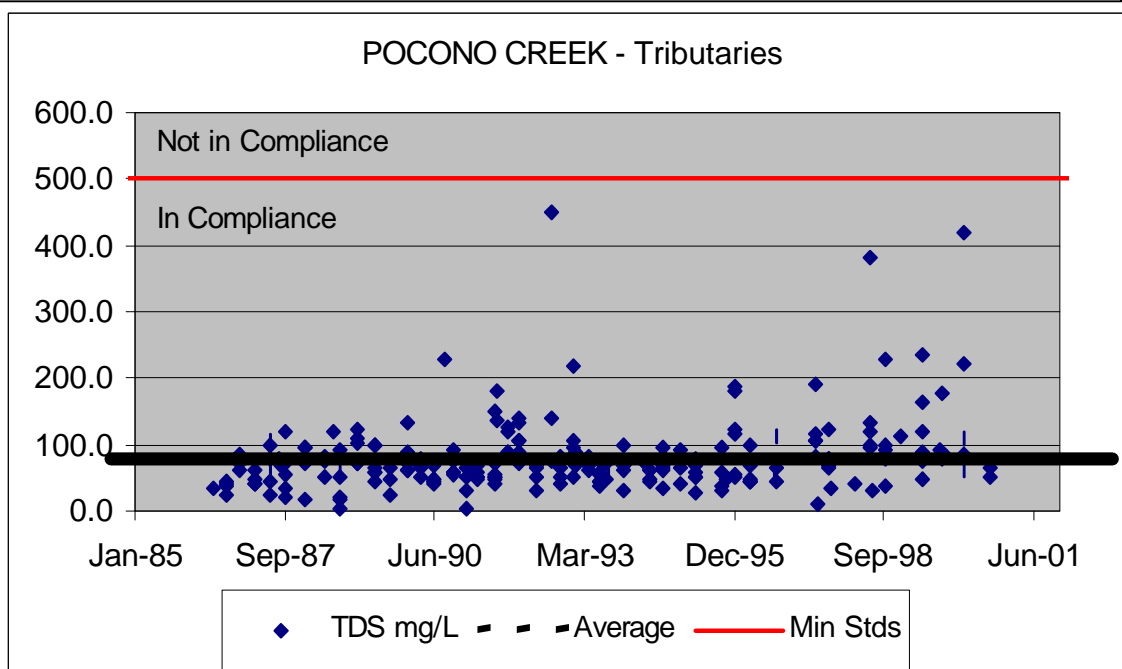


Figure 3 - TDS - Tributaries - By Date

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Examining Figures 4 & 5 shows some of the difficulties with uneven data distribution. Figure 4 shows generally good TDS readings through out the Pocono Creek. Figure 5 shows the tributaries sorted by Management Area, and clearly shows a higher spread in area 3, which you would expect as it is more impervious then 4 or 5. You would expect higher spreads in 2 and 1, but as the data is sparse for tributaries in that region, no conclusions are possible.

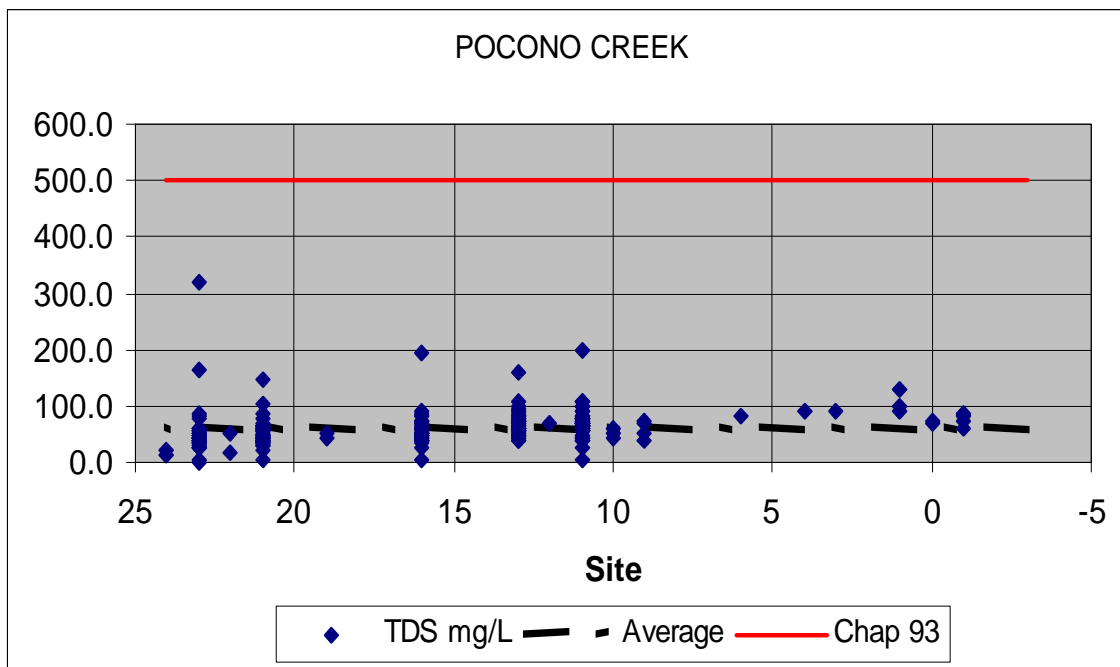


Figure 4 - TDS - Pocono Creek - By Location

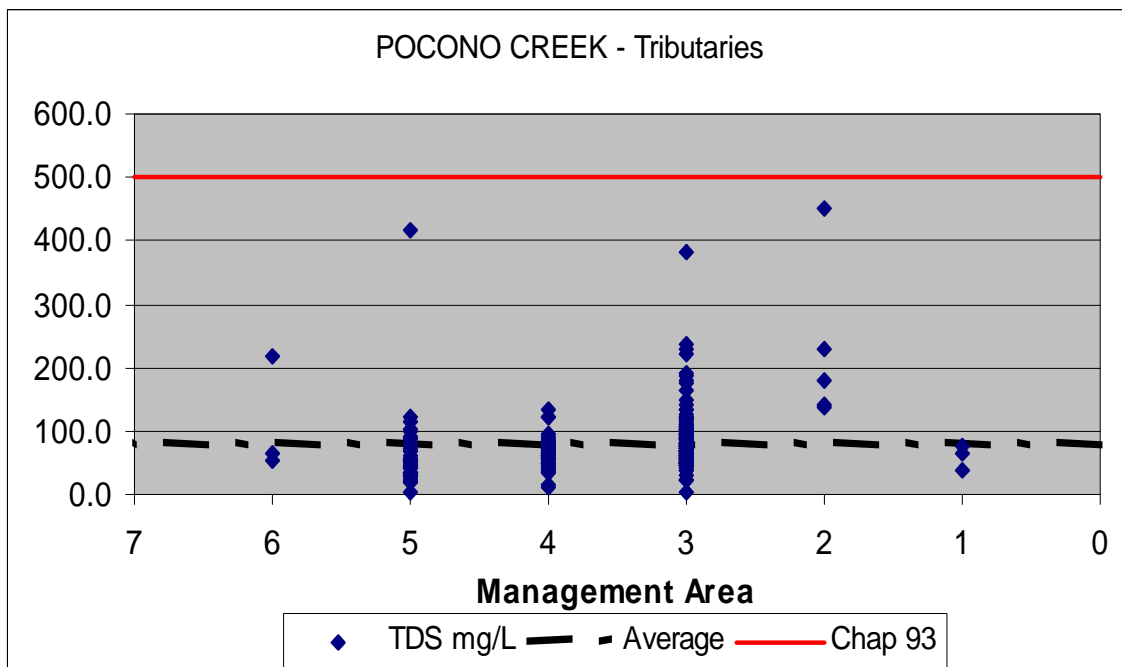


Figure 5 - TDS - Tributaries - By Management Area

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Sample Results - 2 – Temperature

Temperature is the one parameter in the Pocono Creek Watershed that regularly does not meet the statewide temperature standards. Runoff from parking lots, roofs, streets, and detention basins adds heat from solar energy to the streams in urbanizing areas. Removal of shade trees and buffers also adds heat energy to the system. Temperature data for this study is reported as over or below than (plus or minus) the statewide

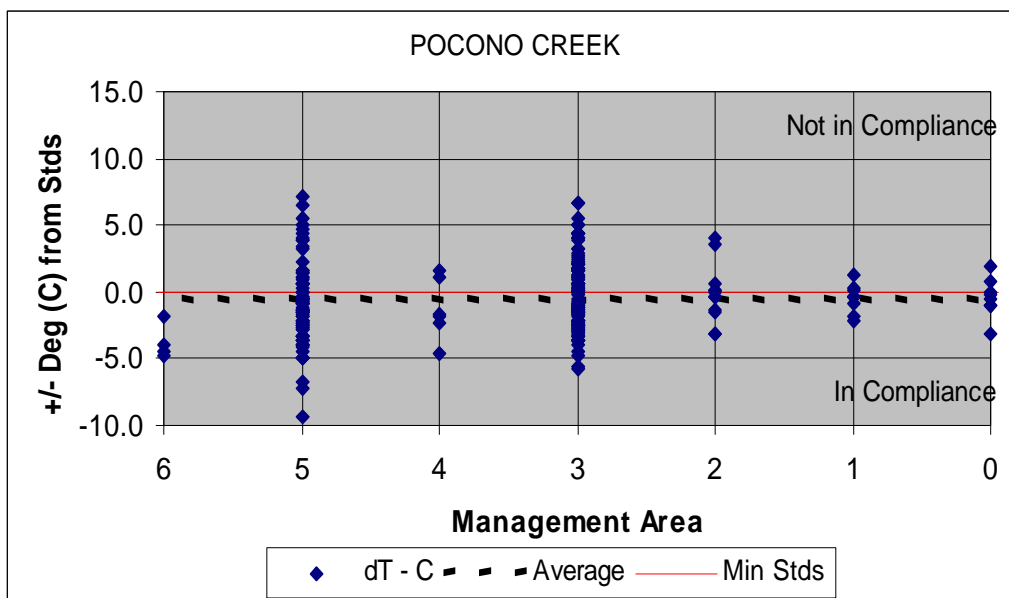
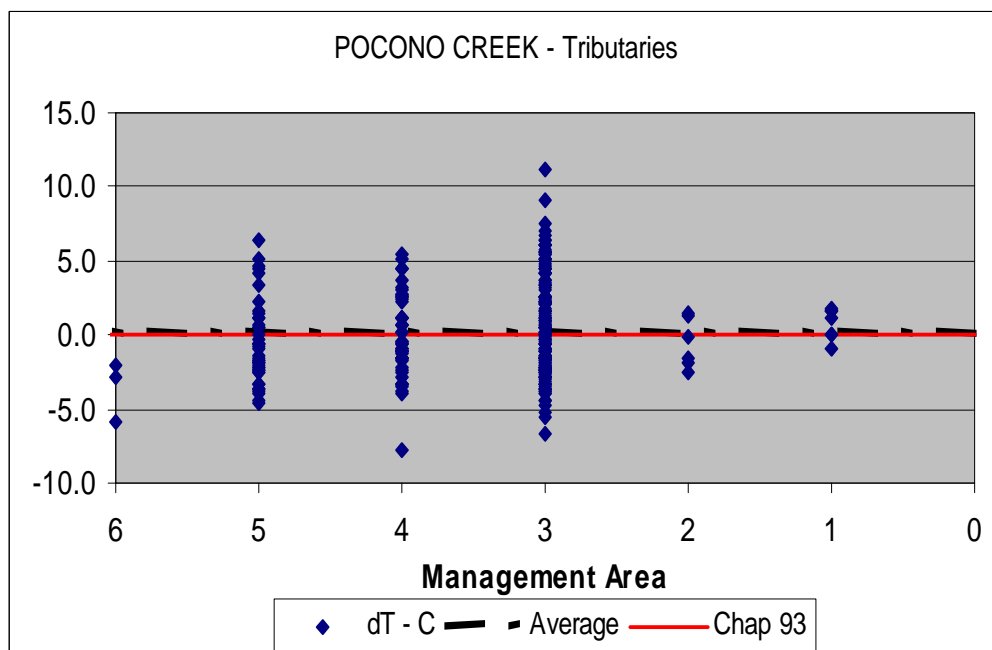


Figure 6- Temperature - Pocono Creek

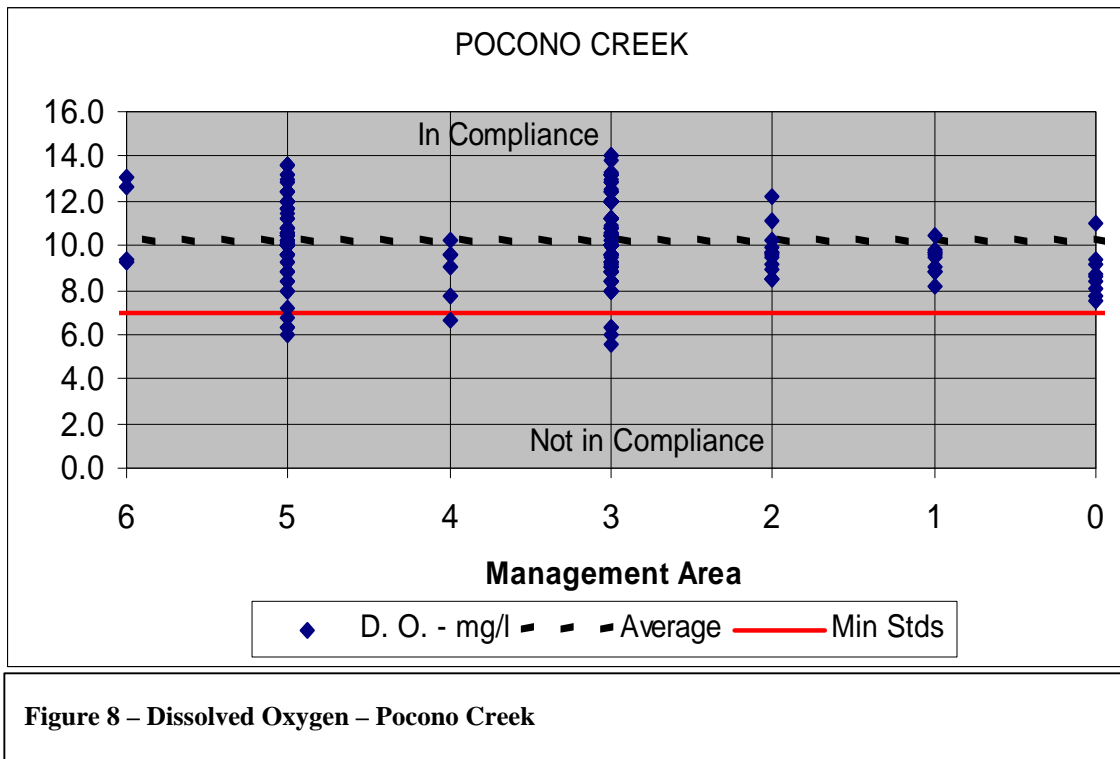


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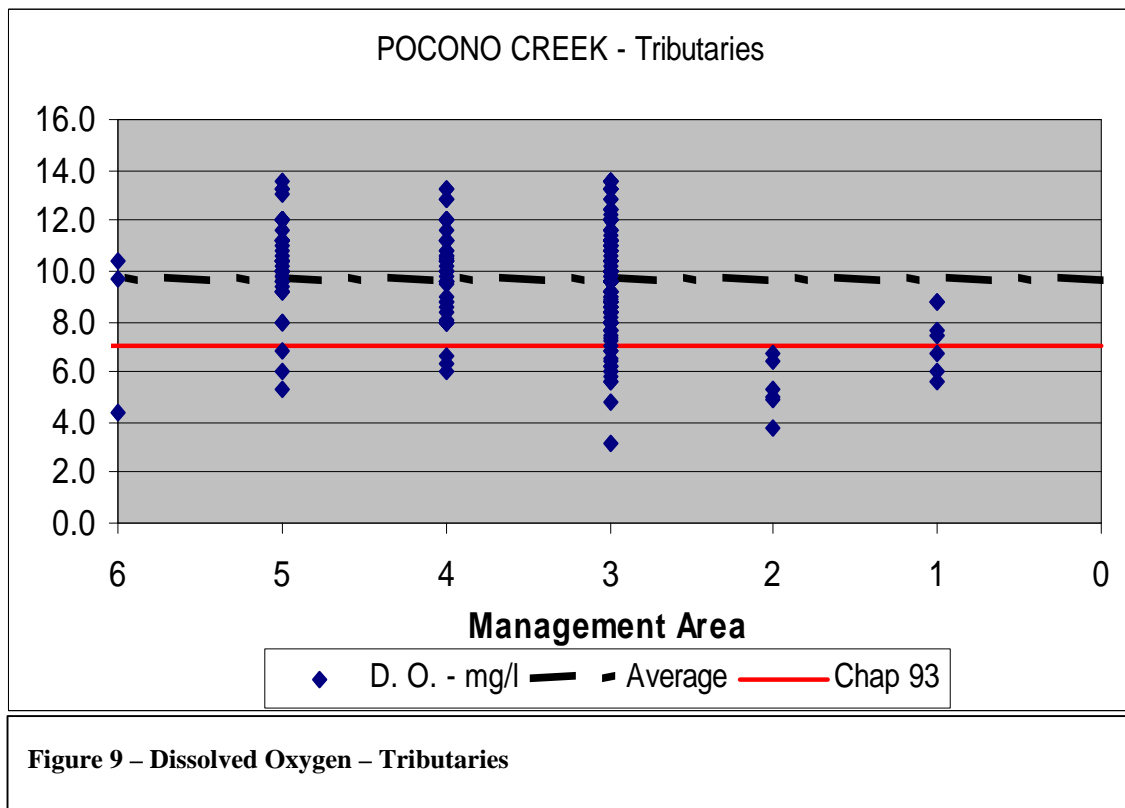
standards for comparison purposes. As shown in Figures 6 and 7, the average just meets the minimum standard for both the creek and the tributaries, but the spread of the readings regularly exceed these standards. Again the lack of data for Areas 1,2 and 6 hampers the analysis. Note that the “spread” of the data in the tributaries is greater then the main stem as would be expected.

Sample Results - 3 – Dissolved Oxygen

Dissolved Oxygen (DO) is a crucial parameter when looking at the health of a stream or watershed, and in this example shows the difference between the results for the main stream and the tributaries. Figures 8 and 9 display the DO data, sorted by management area. While the Pocono Creek only has a few instances where the data is below the state minimum, all of the limited tributary data in area 2 and half of the data in Management Area 1 are below these criteria.



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As no sampling of dissolved metals other aluminum was available, the County added this test to their Aug 2000 water quality parameters, as shown below in Table 5. The amounts detected were minimal.

	P -21	P-1	P-12
Iron	.051	.125	.151
Nickel, Dissolved	<.005 mg/l	<.005 mg/l	<.005 mg/l
Copper Dissolved	ND	ND	ND
Cadmium, Dissolved	ND	.00021 mg/l	ND
Arsenic, Dissolved	<.002 mg/l	<.002 mg/l	<.002 mg/l
Lead, Dissolved	ND	ND	ND
Zinc, Dissolved	ND	ND	ND

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Management Area Water Quality Parameters

In order to support the development of measurable targets for the project, averages were found for each data parameter on the Pocono Creek by management area (Table 6). These values target the main stem of the Pocono and do not include water quality data from the tributaries. Management Areas that had less than ten data points and represented less than 4% of the parameter data readings are underlined. The dashed lines represent management areas where the data was too sparse to determine an average.

The averages have two developed for two purposes. First to provide baseline values for the Pocono Creek, and second as a resource in the development of computer models of the watershed. Once a representative model is developed, it will can be used to verify or fill in missing data. It will also be used to evaluate the performance of different alternatives for the Phase II process.

Table 6 - Pocono Creek Averages by Management Area

Parameter	Samples	Average	MA6	MA5	MA4	MA3	MA2	MA1
BOD	247	-----	-----	-----	-----	-----	-----	-----
Dissolved Oxygen	236	10.2	10.4	10.3	8.6	10.4	9.1	8.4
DO%	236	93%	109%	92%	93%	94%	96%	86%
pH	711	7.0	6.9	7.0	7.2	7.1	7.2	7.1
DTemp	245	-0.5	-3.8	-0.9	-1.3	-0.2	-0.1	-0.5
TDS	226	60.8	48.3	52.3	-----	65.8	71.1	77.4
TSS	35	6.77	5.0	6.7	10.7	6.1	6.5	6.9
Alkalinity	43	21.5	13.9	16.0	16.4	26.4	24.4	21.3
Acidity	41	6.2	4.0	4.2	6.0	5.1	7.1	7.6
Aluminum	161	0.1	-----	0.1	0.1	0.1	-----	0.2
Al-Dis	15	0.1	-----	-----	0.0	0.0	-----	0.1
Chlorides	47	20.9	19.7	21.8	19.4	21.9	21.6	20.4
Fecal Coliforms	246	284	40	40	515	345	1344	314
Hardness	43	35.2	16.8	31.1	28.8	35.8	43.9	36.8
Nitrogen (Ammonia)	227	0.1	-----	0.1	0.1	0.1	0.2	0.2
Nitrogen (Nitrate)	368	0.3	0.1	0.3	0.8	0.2	0.4	0.3
Nitrogen (Nitrite)	28	0.0	-----	-----	0.0	0.0	0.1	0.0
Ortho Phosphate (PO4-)	218	0.2	0.5	0.2		0.3	0.3	0.1
Phosphorus (Total P)	235	0.1	-----	0.0	0.1	0.1	0.1	0.1

Underlined values represent MA with <10 data points and 4% of the samples collected

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Areas of Concern

Inspecting all graphs by location and parameter identified Areas of Concern. Sites with multiple samples that either were not in compliance with statewide standards or were not consistent with the watershed were selected. This list is not exhaustive, as many areas were not sampled with no data available. Table 7 lists the sites, and Figure 10 shows an example of how the locations were identified.

Table 7 - Areas of Concern

Location	MA	DO	PH	Nitrate	TDS	Temp
Pocono Creek - 11,13,16	3					X
Pocono Creek -21	5	X				
Pocono Creek -23	5	X				
Pocono Creek - 21,23	5					X
Flagler Run (F1)	1	X				
Bartonsville Truck Stop Trib. (TB2)	2	X				
Bisbing Run (BI)	3	X	X			
Cranberry Creek (CR1,2,4)	3	X	X		P	
Summit Resort Trib. (TS)	3	X		P	P	X
Scott Run (S1, S3)	4	X				X
Coolmoor Creek(C)	5	X				X
Dry Sawmill Run (DSM1)	6					X

P - readings not consistent with the watershed,

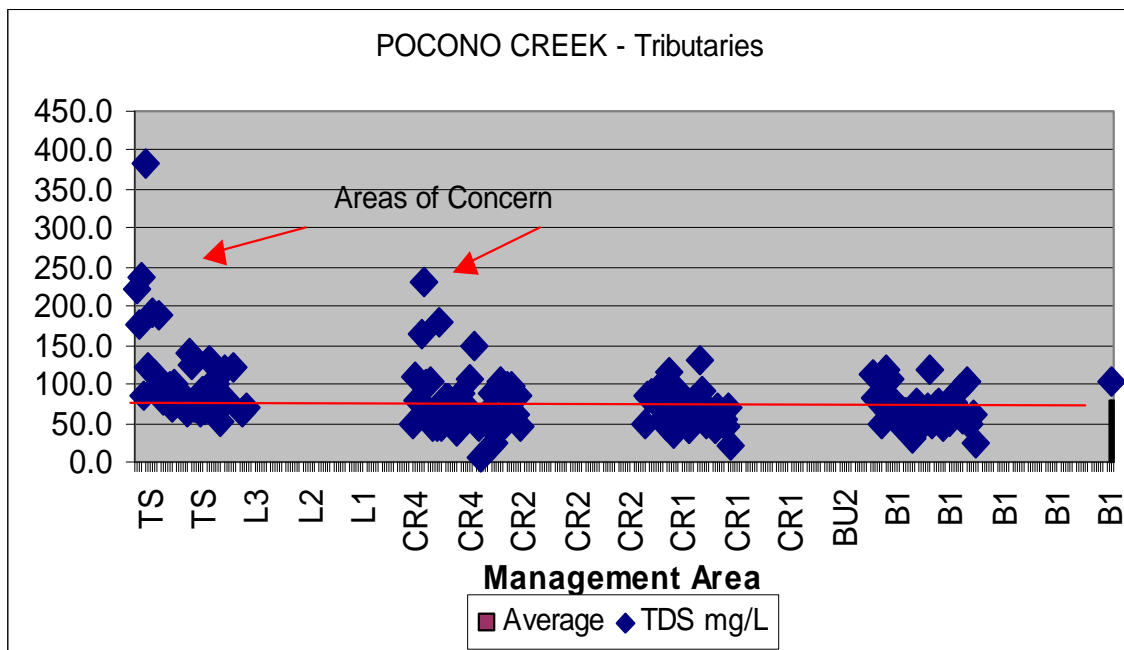


Figure 10 - Areas of Concern - Total Dissolved Solids (MA3)

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Water Quality Targets

The last and culminating task of Phase I is to set targets in support of the goals developed during public meetings at the beginning of the study. Two of the goals directly relate to water quality. They are to *protect water resources* and to *improve the water quality* of the Pocono Creek Watershed. Considering the present water quality of the Pocono Creek and the level of development within the watershed, the water quality targets are set as follows:

- ◆ Where water quality exceeds minimum standards
 - ◆ sustain existing quality
- ◆ Where it doesn't ...
 - ◆ improve quality to minimum standards

The current water quality of the watershed has been found to be good, though some Areas of Concern have been identified. Many studies have found that when the level of imperviousness within the watershed reaches 10%, the “health” of the stream starts to rapidly deteriorate. The next threshold is 25%, where the streams can no longer support a diverse wildlife community (Schueler 1994). Currently, Management Areas 1 – 4 are at or below the 10% value, while Management Areas 5 and 6 are in the 10% to 25% range. Overall the watershed has reached the first threshold, as it is approximately 11%. It needs to be stated that when looking at these studies, imperviousness is both a cause and an indicator, and there are many methods to reduce its impact on a watershed. Also, many of the water quality parameters are also tied to flooding frequency, streambed erosion, management of the land adjacent to streams, etc. The target of phase II is not the impervious area, but the effect of urbanization.

Where water quality exceeds minimum standards...-sustain existing quality. With the current level of water quality on the Pocono Creek, this target is achievable and reasonable. The tributaries from Management Areas 4 – 6, and the entire Pocono Creek are included in this target.

Where it doesn't ...improve quality to minimum standards. This will apply to the areas of concern, most probably the tributaries within Management Area 1,2 and 3.

Guidance for Future Sampling

- Coordinate sampling between groups to increase the frequency of sampling.
 - Insure the downstream station of each management area is sampled several times a year.
 - Include representative tributaries within each management area.
- Coordinate testing limits and methods to aid in developing long term parameter averages.
- Sample at a minimum DO, Temp, BOD, TDS, TSS, and pH during each sampling event.

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